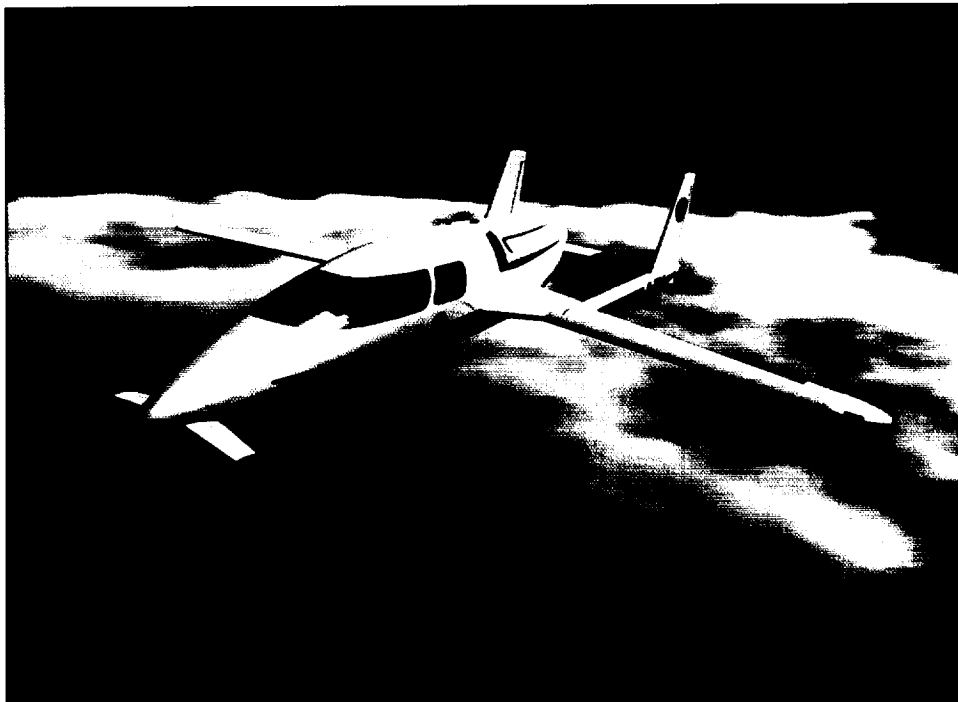
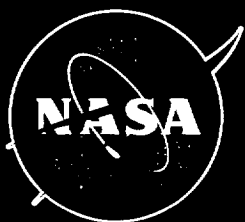


National General Aviation Design Competition Guidelines

1999-2000 Academic Year

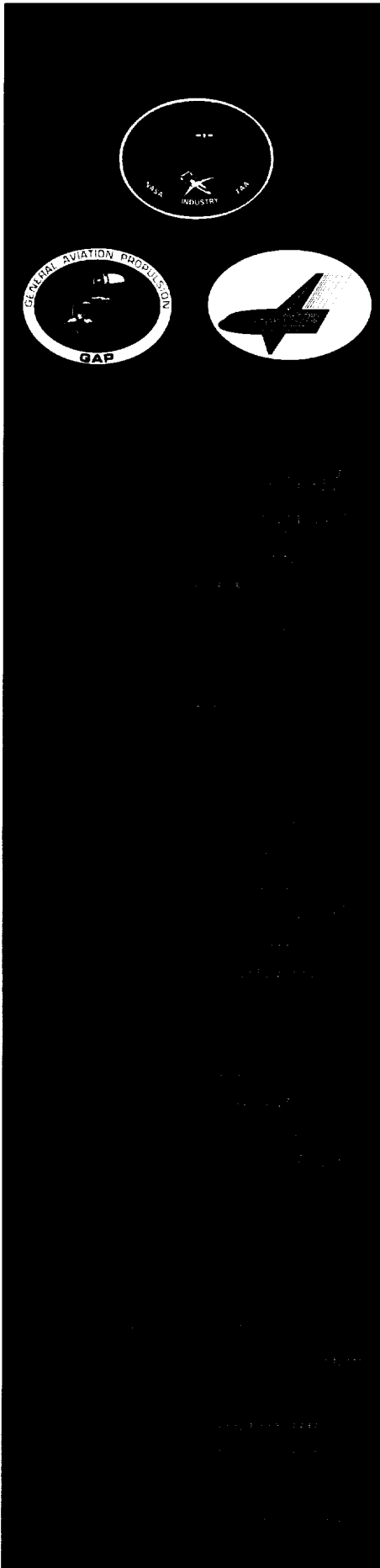


The National Aeronautics and Space Administration (NASA), the Federal Aviation Administration (FAA) and the Air Force Research Laboratory are sponsoring a National General Aviation Design Competition for students at U.S. aeronautical and engineering universities for the 1999-2000 academic year. The competition challenges individuals and teams of undergraduates and/or graduate students, working with faculty advisors, to address design challenges for general aviation aircraft.

Now in its sixth year, the competition seeks to increase the involvement of the academic community in the revitalization of the U.S. general aviation industry while providing real-world design and development experiences for students. It allows university students to participate in a major national effort to rebuild the U.S. general aviation sector while raising student awareness of the value of general aviation for business and personal use, and its economic relevance. Faculty and student participants have indicated that the open-ended design challenges offered by the competition have provided the basis for quality educational experiences.

The competition is divided into two categories, each with separate guidelines and time lines. The first is the ***Innovative Design Category*** (see pages 3-4), under which individual students or student teams submit paper design projects of systems, subsystems, components or complete airframes to address general aviation revitalization goals. Five cash awards are offered in this category, including special awards for product designs which are readily retrofitable to existing aircraft and those which make innovative use of Air Force-developed technologies. The second category, ***Design It, Build It, Fly It*** (see page 5), allows individual students or student teams to take well-developed design projects to a proof of concept or demonstration stage. The award for this category includes a cash development grant and the opportunity to demonstrate the concept at the Experimental Aircraft Association's (EAA) *AirVenture* held in Oshkosh, Wisconsin.

All design packages will be reviewed by a panel of industry, university and government experts and written feedback will be provided to the participating teams.



General Aviation (GA) includes all flight operations except commercial airlines and military. The 192,000 GA aircraft in service account for 58 percent of all U.S. flight hours, 33 percent of all miles and 76 percent of all departures in the United States. During its peak in 1978, U.S. manufacturers delivered nearly 18,000 new GA aircraft. Between 1979 and 1994, production dropped below 1000 new aircraft per year. Today's GA market is showing a steady recovery with more than 2,200 new aircraft shipped during 1998.

With the start of the GA industry revitalization, universities have begun to recognize general aviation as an area for teaching and research. The government sponsors and their partners developed this competition to create this trend and to integrally involve faculty and students in national efforts to revitalize this important sector of aviation. This competition is an example of the type of new partnerships NASA is forming with academia to capture the bold initiative, innovation, talent and enthusiasm present in our Nation's academic community. NASA and the FAA have shown that this kind of competition serves to stimulate breakthroughs in technology and their application in the GA market.

The revitalization initiative is concerned, in part, with how to make general aviation more appealing for business as well as personal use. Revitalization efforts are making general aviation flight easier and more convenient. Improvements in air traffic control accessibility, as well as improved safety, comfort, reliability, dependability and performance are needed to raise user satisfaction. State-of-the-art technologies need to be applied to training and certification to make these goals a reality.

The average general aviation aircraft is 27 years old and incorporates technology which is generally outdated. Current flight deck technologies range from the

1950's to the 1990's; piston propulsion technologies are more than 40 years old. Revitalization efforts encourage newer, more efficient, and user friendly technologies.

Among the more recent technologies which can be harnessed in revitalization efforts are new air traffic control and navigation tools, such as digital datalink and satellite navigation. New computer and display technologies, and new materials and composites processes are just a few of the existing technologies which can be applied to general aviation revitalization.

The revitalization initiative seeks to bring about increased use of general aviation in the U.S. which will, in turn, increase the volume of aviation production. Its success will have a vital and positive economic impact. Revitalization goals include:

- ➔ Expanding the Nation's economy to "off airways" communities;
- ➔ Increasing efficient utilization of the Nation's airspace;
- ➔ Creating world-wide demand for new, U.S.-built, "owner-operated" small business and personal aircraft; and,
- ➔ Creating jobs in airframe, engine, avionics, airport, and training industries.

A number of key engineering objectives (see page 6) have been established for the revitalization effort. Design teams should incorporate these objectives into their selection of design challenge(s) and their approach.

COMPETITION COORDINATOR

Virginia Space Grant Consortium
Old Dominion University Peninsula Center
2713-D Magruder Boulevard
Hampton, VA 23666

Phone: (757) 865-0726

Fax: (757) 865-7965

E-Mail: msandy@odu.edu

Questions regarding the competition should be provided in writing. At the sponsors' discretion, queries and responses may be made available to all design teams on a periodic basis.

Innovative Design Category

KEY DATES

*Letter of Intent
due no later than
January 31, 2000*

*Design Submittal
by May 2, 2000*

*Awards Ceremony
August 2000*

U.S. colleges with at least four-year accredited engineering programs may compete. It is anticipated that this project will be undertaken as part of a formal undergraduate or graduate engineering course. Student professional societies may also participate in the competition, either independently or as a partner to an academic course effort. All design projects must be developed under the guidance of a university faculty advisor. Universities are encouraged, but not required, to take a multi-departmental approach and/or team with other academic organizations. Teams may choose to consult directly with industry representatives but are not required to do so.

For the purposes of the competition, general aviation aircraft are defined as fixed-wing, single-engine, single-pilot aircraft for 2-6 passengers, turbine or piston. The performance specifications are 150-400 kts with a range of 800-1,000 miles.

For the successful revitalization of General Aviation, short term applications of AGATE technologies are needed. To support revitalization goals, successful designs should focus on technologies with most immediate and cost effective impact. Designs for systems or subsystems with retrofit applications are encouraged; however, whole aircraft designs will be considered. Designs will

be primarily judged on their potential impact on the marketplace. Emphasis will be on affordable technologies and increased utility in both retrofit and new aircraft. See page 4 for design submission requirements.

Teams should address design challenges in one or more of the following six technical areas:

- ◆ Integrated Cockpit Systems
- ◆ Propulsion, Noise and Emissions
- ◆ Integrated Design and Manufacturing
- ◆ Aerodynamics
- ◆ Operating Infrastructure
- ◆ Unconventional Designs
Such as Roadable Aircraft

Teams are encouraged to consider more than one of the technology areas in their design package. It is desirable that interfaces with other systems be addressed. For example, if an operations concept is developed for an ice protection system, additional credit will be given if the design also considers the interaction with a cockpit weather system for graphical display for forecasting icing conditions and/or the design of an operational interface for the pilot. Retrofit options for existing aircraft offer great potential for meeting revitalization goals. Some areas where innovative designs with near-term applications are desired include, but certainly are not limited to:

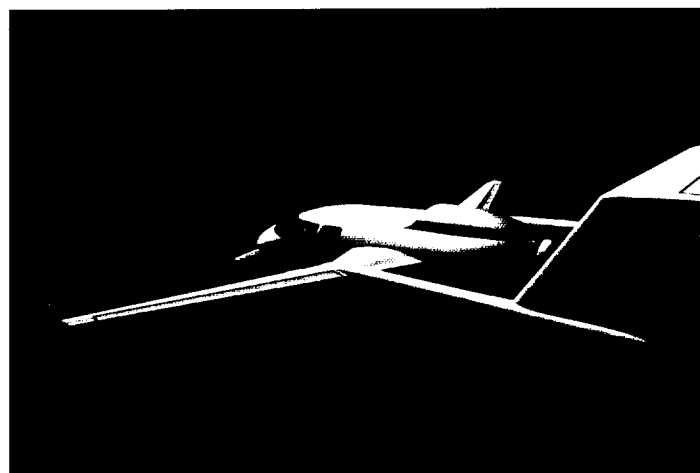
- ◆ Affordable collision avoidance systems
- ◆ Situational awareness aids
- ◆ Single lever power control systems
- ◆ User friendly, effective, low fuel warning systems
- ◆ Effective alarm and warning management options
- ◆ Improved exterior lighting

Two additional sponsored awards are offered in this year's competition. The AOPA Air Safety Foundation is sponsoring an award for the best retrofit design and the Air Force Research Laboratory is offering an award for the best use of Air Force-developed technologies. The Competition Coordinator can assist teams with making connections to appropriate Air Force, NASA, or FAA contacts as needed.

LETTER OF INTENT

A letter of intent to participate in the *Innovative Design* category must be submitted by the faculty advisor. The letter of intent should provide full contact information for the advisor (including fax and e-mail if available) as well as a general description of how the design package will be approached. Specific course involvement should be noted, as well as that of student professional societies and industry or other participants.

Letters must be received no later than January 31, 2000; however, it is in the team's interest to submit a letter of intent as early as possible. Individuals providing letters of intent will receive additional general aviation background material which will be helpful in the design process, as well as additional information on evaluation criteria and any other competition updates as they become available.



INTEGRATED COCKPIT SYSTEMS

1. Reduce time and cost to learn and maintain all-weather safe operations skills by 50 percent (from current level of >1000 hours).
 - Achieve integration of weather, navigation (moving map), terrain/obstacle database, traffic situation, and wake vortex information into one multi function display.
 - Achieve integration of simplified flight controls with flight guidance displays.
 - Develop integrated computer-based training systems that coordinate the use of both on-board and desktop computers and displays (including virtual reality).
2. Reduce dependence on ground controller voice communications for safe, random access, point-to-point navigation in future air traffic systems.
3. Implement situational awareness technologies and operating systems to reduce accidents and fatalities caused by weather (icing, low visibility, convective weather) as a primary factor.
 - Achieve integration of expert systems for flight training, planning, operations, propulsion system management decision aiding, icing avoid and exit decision aiding, and emergency decision-making.
4. Establish requirements for preferred, affordable datalink for GA usage.
5. Reduce cost of near all-weather flight systems by 50 to 80 percent.

PROPULSION

1. Establish certifiable digital single-lever powerplant control systems.
 - Emphasis on reducing costs: extending time between overhauls, increasing fuel economy, and reducing direct operating costs.
 - Address safety by reducing pilot workload and increasing engine reliability.
2. Develop engine diagnostics and condition monitoring for greater safety, efficiency and lower cost.
 - Identify critical in-flight conditions, capture non-critical conditions for analysis/trending and pre/post-flight diagnostics.

- Emphasis on low-cost, high reliability, low incidence of false alarms, and reduced emissions through improved operational control.

3. Develop innovative propulsion design which incorporates alternate fuels, low emission and low noise technologies.

INTEGRATED DESIGN & MANUFACTURING

1. Develop and validate low-cost manufacturing methods to reduce airframe and propeller cost and weight.
 - Achieve reduced cost of manufacture of airframe components by 25 to 40 percent.
2. Develop and validate Quality Control/Non Destructive Evaluation (NDE) methods to reduce airframe cost and weight, increase quality of production, and reduce cost of maintenance.
 - Achieve reduced dependence on manual inspections through in-process NDE quality control for composite manufacturing processes and thus reduce time and cost for composite structure design validation.
 - Develop low-cost inspection techniques for airframe structure.
3. Develop and validate advanced crashworthiness concepts and design methods to reduce full-scale testing requirements for certification.
 - Achieve increased survivability through low-cost, energy absorbing structural design concepts and advanced restraint devices.

AERODYNAMICS

1. Develop computer-driven configuration design optimization code and use to improve a current production aircraft.
2. Develop active noise reduction system for interior use in general aviation aircraft.
3. Design improved, single-flap high-lift system to reduce noise footprint in airport vicinity for both takeoff and landing phases of operation.
4. Develop technique to predict drag in both cruise and takeoff configuration to within 5% and apply to a production aircraft.

5. Develop technique to accurately predict aileron and elevator loads for large control surface deflections.
6. Design a method for protecting the leading edges of laminar-flow surfaces from aerodynamic contamination.
7. Reduce cost for design and manufacture of ice protection systems for laminar flow wings.
8. Reduce cost for design and manufacture of ice protection systems for horizontal tailplanes.
9. Develop unconventional designs, such as roadable aircraft, which consider break through technologies for affordable designs that could capture a mass market.

OPERATING INFRASTRUCTURE

1. Reduce the operating complexity and costs for airspace and ground systems infrastructure equipment and procedures for both pilots and air traffic managers.
 - Achieve simplified situational awareness and decision-making between pilots and controllers for "free-flight" or "direct-flight" capabilities.
 - Develop design concepts for advanced Communication/Navigation/Surveillance (CNS) air and ground systems based on datalink and satellite navigation technologies to reduce reliance on ground-based radar and voice communications.
2. Establish means for increased utility of airports in advanced air traffic management ("free-flight") environment.
 - Achieve integration of commercial information systems (rental cars, accommodations, food services, operational services) with flight information (weather, traffic, procedures, facilities databases) systems for all general aviation airports.
 - Achieve low-cost implementation of all-weather operational CNS capabilities for airports and heliports without precision landing capabilities in current instrument landing systems.

DESIGN PACKAGE

Ten sets of the entire design package must be received by the Competition Coordinator no later than May 2, 2000.

Reviewable sections listed below are subject to a total page limit of 40 double spaced pages in 12-point type. For evaluation purposes, reviewers will focus on the main body of the design proposal, but will reference the required appendices at their discretion. The six sections and required appendices should be readily identifiable.

Main Body of the Design Proposal:

1. Executive Summary.
2. Background on the recent history and status of general aviation in the U.S. This section should broadly address issues relating to revitalization and demonstrate that the team has a clear understanding of the issues.
3. A concise statement of the design challenge(s) you have chosen to address and how these design challenges relate to U.S. general aviation revitalization goals.
4. Description of the team's systems engineering approach to the problem. This section should include a description of the team and its overall approach to the problem.
5. A description of how each of the technical areas is addressed in drawings, mockups, computer codes, etc., as appropriate to provide evidence of a thorough design process.
6. Description of the projected impacts of the team's design with a thorough discussion of how it meets general aviation revitalization goals. This section should address the commercial potential for the design, including a description of processes that would need to be undertaken to bring the design to the product stage. Emphasis should be on increased affordability and utility.

Appendices A-D are required, but not included in the 40-page limit.

- A. List of complete contact information (use permanent addresses) for all advisors and team members. Include e-mail, fax and phone numbers.
- B. Description (approximately one page) of the university, college, professional society, industry, or other institutions involved in the project.
- C. Sign-off page for faculty advisor(s) and department chair(s).
- D. Evaluation of the educational experience provided by the project.

The following appendix is optional:

- E. Other support material: additional drawings, computer codes and other design elements as appropriate.

AWARDS

An awards ceremony will be held in August 2000. Awards are anticipated as follows:

\$ 5,000 Award
to the University Academic
Department of First Place Winner

\$ 3,000 First Place Award
to Design Team

\$ 2,000 Second Place Award
to Design Team

\$ 1,000 Third Place Award
to Design Team

ADDITIONAL SPONSORED AWARDS

The Air Force Research Laboratory



is offering a \$3,000 team award for an aircraft design or aircraft subsystem design which meets all criteria for the National

General Aviation Design Competition and includes Air Force-developed technologies. Background on Air Force technologies is available at <http://www.afrl.af.mil> under Technology Transfer or through the AFRL Tech Connect Hotline at (800) 203-6451. The design package should identify the applicable Air Force technologies and document the source.

The AOPA Air Safety Foundation is

providing a Best Retrofit Potential Award of \$500 to a student design team.

This award will be given for the best technological innovation that can be readily adapted to existing aircraft and offer a cost effective, near-term solution to technology upgrades. Special consideration will be given to the practicality of the design, including cost and ease of implementation within the existing fleet.





The *Design It, Build It, Fly It* category encourages students to take design concepts to a higher level "flight proof-of-concept or flight concept demonstration phase".

This competition category is open to proposals that can demonstrate completion of the design phase of a concept with high relevance for General Aviation revitalization goals (see page 6). Such concept flight demonstrations might include, but are not limited to, prototype flight testing, in-flight simulation, in-flight software demonstrations, radio control models, and other proof of concept flight testing as appropriate. Proposals need to demonstrate a thorough design phase and applicability to AGATE engineering goals and objectives. This competition category fosters the development of viable concepts while continuing to meet the educational objectives of the National General Aviation Design Competition. **NOTE:** *Proposals do NOT have to be derived from previous National General Aviation Design Competition submissions.*

U.S. universities with at least a four-year accredited engineering program may participate in this category of the competition. Student teams or individuals under the guidance of faculty members should submit proposals, to include budget requirements, for seed funding. The total award pool is \$10,000. Funding will be provided to the winning proposal(s) at the beginning of the build phase by the government sponsors of the competition. The proposal should include a design summary, plans for the demonstration phase, timeline, and budget for the project. The proposal must include measurable progress points, as well as a plan for providing timely updates to the sponsors. Ties to GA revitalization goals must be presented. An appropriate aviation safety review process is required. Matching contributions from industry are encouraged and should be delineated in the proposal and explained in a budget narrative. Universities are encouraged to involve industry, EAA

chapters, and other appropriate aviation organizations. These groups might provide matching contributions, either cash or in-kind. The greatest contributions from such alliances can come from access to experts and exposure to industry culture/climate and role models for students. The practical knowledge and enthusiasm of EAA chapter members would be an asset to participants. The EAA Technical Counselors and Flight Advisors could participate by providing consultation in flight test planning and implementation. Participation by AGATE industry experts is also encouraged. A list of AGATE contacts is provided at: <http://agate.larc.nasa.gov>. Proposers needing assistance in connecting with the EAA, AGATE industries or contacts at other sponsoring organizations should contact the Competition Coordinator.

The competition particularly welcomes component design challenges. A few examples follow, but are only offered to stimulate thinking on the part of proposers:

- ➔ concepts that are retrofitable to existing aircraft
- ➔ angle of attack sensors and indicators
- ➔ new fuel quantity sensing systems
- ➔ single or multi channel stabilization systems
- ➔ new types of sensors for aircraft propulsion systems
- ➔ altitude hold systems and indicators
- ➔ electro-mechanical trim actuators
- ➔ crash survivable seats

The possibility for flight testing on the EAA's GlaStar aircraft can be explored for appropriate proposals. The GlaStar is a two-place high-wing aircraft with conventional aluminum wings. It has a composite fuselage covering a steel tube framed cockpit and is powered by a Lycoming engine. The aircraft is equipped with reconfigurable electronics capability and can accommodate a variety of flight test equipment. This venue should be discussed prior to proposal submission with the Competition's Coordinator.

Proposals must include the following:

- ◆ an executive summary;
- ◆ design overview with support documentation;
- ◆ plans for the development and demonstration phase, including how student teams/or individuals will approach this phase;
- ◆ flight safety review process;
- ◆ timeline to comply with award requirements;
- ◆ plans for development and peer review of the technical report;
- ◆ budget with narrative, including travel costs to *AirVenture*;

- ◆ sign-off page for faculty advisor(s) and department chair(s);
- ◆ letter of institutional commitment to the project signed by the individual(s) authorized to make sponsored program commitments for the submitting institution(s); and
- ◆ letters of commitment from industry or other partners for matching contributions.

Ten sets of the entire proposal package must be received by the Competition Coordinator no later than February 4, 2000.

Text should be double-spaced and 12-point type should be used. The narrative portion of the package may not exceed 40 pages in length and will be the primary focus for evaluators. Drawings, computer codes, video and other appropriate design elements may be included as attachments.

Post Award Requirements: The time frame for building and testing of the winning proposal(s) has been expanded to a full academic year. The winning proposal(s) will be announced by March 17, 2000. The winning team(s) will then have until May 31, 2001 to complete their project. The winning team(s) must present, exhibit and provide demonstrations (as appropriate) at the EAA's *AirVenture* during summer 2001. Additionally the winning team(s) are required to submit a flight test technical report summarizing the results of the testing. Peer review of the technical report from the flight test community is required before publication and distribution. A safety review will be performed if required by the sponsors.

AWARDS

\$ 10,000 Building Fund

\$ 500 Student Prize

Government sponsors anticipate making up to two awards from a total award pool of \$10,000, though the entire pool can be given to one winning proposal.



The Experimental Aircraft Association is sponsoring a \$500 per team student award. The EAA prize money will be awarded at *AirVenture* following delivery of the flight test technical report and exhibit and/or demonstration of the flight article. Information on the EAA and *AirVenture* is available at <http://www.eaa.org>.